Evolutionary Algorithms for offline and online optimization of fed-batch fermentation processes

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In this work, Evolutionary Algorithms (EAs) were used to control a recombinant bacterial fed-batch fermentation process that aims to produce a bio-pharmaceutical product. Initially, a novel EA, based on real-valued representations and that makes use of individuals with variable sized chromosomes, was used to optimize the process, prior to its run (offline optimization), by simultaneously adjusting the feeding trajectory, the duration of the fermentation and the initial conditions of the process[2]. A white box mathematical model derived from literature[1] and fine tuned by practice was used in the fitness function, based on differential equations and kinetic algebraic equations. Outstanding productivity levels were obtained and the results are validated by practice. Finally, online optimization is proposed, where the EA is running simultaneously with the fermentation process, receiving information regarding the process, updating its internal model and reaching new solutions that will be used to online control. Results obtained by simulation of the system show that without online optimization minor changes cause the process to reach sub-optimal levels in the long run. On the other hand, when online optimization is performed, minor changes are corrected and the behaviour of the system is near optimal.

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